Express Mail No.: E US

METHOD FOR RECOGNIZING A STRUCTURE TO BE APPLIED ONTO A SUBSTRATE WITH MULTIPLE CAMERAS, AND DEVICE THEREFORE

[0001] The present invention relates to a method for recognizing a structure to be applied onto a substrate with at least one or more cameras in accordance with the generic part of claim, and a corresponding apparatus therefore.

[0002] For recognizing a structure to be applied onto a substrate it has been customary to carry out optical measurements, whereby frequently various systems for fully automatic testing of the structure, including adhesive and sealing agent lines, are used for this purpose. For this purpose, multiple video cameras are directed at the structure to be recognized, whereby, in addition, an illumination module serving to generate a contrast-rich camera image is required.

[0003] In order to be able to monitor an adhesive line and/or adhesive trail while it is being applied, it is necessary to teach-in a reference adhesive trail, i.e. to have the camera or cameras scan the reference adhesive tail, in order to calculate therefrom corresponding parameters on which the assessment of the applied adhesive trails is based subsequently.

[0004] Until now, it was necessary in the teaching-in of a reference adhesive trail for each camera to individually scan the adhesive trail in order to obtain camera images for all positions. For the use of three cameras, this means that the reference adhesive trail had to be scanned thrice in sequence and the three different sequences of images of the three cameras had to be assigned. This is disadvantageous in that it results in the parameterization of the reference adhesive trail being cumbersome and time consuming and can lead to high inaccuracy.

[0005] Moreover, there is a need for a method for recognizing a structure to be applied onto a substrate for at least one or more cameras, which method is used to monitor an application structure or adhesive trail at high accuracy and speed while it is being applied.

[0006] It is therefore the object of the present invention to provide a method for recognizing a structure to be applied onto a substrate for at least one or more cameras, which method facilitates rapid start-up at high accuracy and/or quick teach-in of the reference adhesive trail.

[0007] Moreover, it is an object of the present invention to provide a method for recognizing a structure to be applied onto a substrate For at least one or more cameras, which method monitors an application structure and/or adhesive trail at high accuracy and speed while it is being applied.

[0008] Moreover, it is an object of the present invention to provide a suitable apparatus for carrying out the method according to the invention.

[0009] These objects are met with regard to the method by the features of claims 1 and 4, and with regard to the apparatus by the features of claim 28.

[0010] In the apparatus according to the invention and the method according to the invention, a reference application structure is taught-in and further applied application structures and/or adhesive trails are compared to the reference application structure for assessment thereof. In this context, it is irrelevant whether the application facility according to the invention! i.e. the application facility with cameras, or, as a kinematic inversion, the substrate is being moved.

[0011] The method according to the invention facilitates, by means of teaching-in a reference application structure, the recording and/or storing of the images of all cameras in a sequence of images after by means of just a single scan of said reference application structure. This reduces the time until start-up of an apparatus of this type to a short teach-in time.

[0012] According to a method according to the invention for recognizing a structure to be applied onto a substrate, preferably an adhesive line or adhesive trail, with at east one camera, in particular multiple cameras, whereby the applied structure, during the scanning for assessment of this structure, is processed in the form of an optical

representation such that each camera records just a strip of the image to form a sequence of images and the image recording rate is increased in line with the data reduction achieved by recording only a strip of the image, is obtained an advantageous recognition method and monitoring method for a structure to be applied that is highly accurate and can be fully automated. This allows the adhesive trail to be monitored in parallel and/or simultaneous to the application of the adhesive trail.

[0013] Further advantageous developments are evident from the subclaims. Accordingly, it is advantageous for each camera to record only a strip of the image to form a part of the sequence of images in order to minimize the data to be included in the calculation. Since less data has to be included in the calculation and because of the high image recording rate, it is feasible to record comparably small partial sections of the whole adhesive trail to be recorded, for example between 1 mm and 3 mm, such that the adhesive trail being a type of vector chain, can be followed automatically in the individual images.

[0014] Moreover, it is advantageous to increase the image recording rate in line with the data reduction achieved by recording only a strip of the image, which is facilitated in particular by the use of the partial scanning technique, such that a higher frame rate is attained. It is therefore feasible to capture images synchronously and in parallel by all cameras at the same time. The image recording therefore proceed at defined fixed time intervals and is independent of the robot control.

[0015] According to the invention, the image strips of the individual cameras are joined to form a single image which is advantageous in that the respective images of the individual cameras are assigned accordingly independent of location and can be recorded and processed synchronously. In addition, this prevents errors in the teach-in since the images of the individual cameras are always assigned with correct time and location.

[0016] According to a preferred embodiment, per each camera only approx. 1/4 of the image lines are used as image strip and this is used to quadruple the image recording rate. Moreover, it is advantageous if the parameterization of the sequence of images

obtained from the reference application structure that results from a single image recording run of all cameras is carried out automatically by means of a one-time external indication and/or external marking (for example by means of a mouse click) of the reference application structure, and used for comparison to an applied adhesive trail. In particular, the robot travel path, the robot travel time, the direction, the width and the quality of the adhesive frail are used for parameterization. This simple parameterization procedure reduces the risk of maloperation or incorrect parameterization, whereby the system can be operated by personnel with low qualification also. Thus, this parameterization generates a vectorization of the entire adhesive trail, whereby this vectorization provides for reliable and automatic monitoring of the adhesive trail because of the high image recording rate. In addition, this results in a switch of the sensor head only requiring recalibration and/or new calibration without having to teach-in the adhesive trail again.

[0017] According to a preferred embodiment of the invention, an assessment function, in particular a fuzzy assessment is used to analyze the adhesive agent track and/or adhesive trail! whereby in particular the width of the pair of edges comprising the right and the left edge of the adhesive trail, the mean gray scale value of the projected gray scale value profile between the pair of edges, the edge contrast, and the progression of position are included in the calculation by means of the assessment function, whereby, as a result, the adhesive trail can be described accurately such that the adhesive trail can be recognized automatically in a reliable fashion.

[0018] Moreover, it is advantageous for the edge of the adhesive trail to be determined on a surrounding track and/or orbit and, in particular, an essentially circular track and/or circular line in order to capture any progression of the adhesive trail around the application facility in a defined area. In this context, the adhesive trail progresses within the surrounding track that can be elliptical, polygonal or approximately circular.

[0019] According to a preferred embodiment, the center of the circular line or of the surrounding track essentially coincides with the site from which the adhesive emanates to form the adhesive trail, whereby each camera monitors at least one segment

of the circle formed by the circular line.

[0020] Errors at the transition from one camera to the next can be reduced by having each camera monitor at least one overlapping area jointly with at least one adjacent camera.

[0021] It is particularly advantageous for the angle values of the circular line from 0 to 360° to form a global coordinate system of the individual cameras, whereby a segment of the circular line is assigned to the images of the individual cameras. As a result, the progression of the adhesive trail can be followed by at least one active camera, whereby statements concerning the entire adhesive trail as well as its position and/or progression can be made by relatively simple means.

[0022] According to a preferred embodiment, a first camera covers a range of angles from -10° to 130°, a second camera a range of angles from 110° to 250°, and a third camera a range of angles from 230° to 10°, in case three cameras are being used.

[0023] Moreover, during the progression of the adhesive trail, it is advantageous to switch automatically from one camera to the next when the adhesive trail progresses from the segment of a circular line of one camera via the overlapping area to the segment of a circular line of a different camera. As a result, it is feasible to reliably follow the progression of the track and/or position of the track, and these are predictable accordingly. Therefore, fully automatic switching between neighboring cameras can occur such that the parameterization times are reduced.

[0024] Moreover, it is advantageous if LED illumination means the color of which provides a suitable contrast to the color of the application structure are used for illumination. In this context, the color of the light is selected such that, according to the principle of complementary colors, the maximal contrast between the substrate and the adhesive trail results. It is advantageous to use infrared LEDs or UV LEDs. Particular advantages result from using light-emitting diodes whose particular design allows them to emit red, green] and blue light, in particular upon the use of RGB LEDs. As a

consequence the sensor design can be switched to a corresponding adhesive color without further reconfiguration.

[0025] If LEDs with the triple colors, red, green, and blue, are used, the most suitable mixed color can be generated for optimal contrast.

[0026] According to a further development of the invention, the LEDs are flashed, whereby, in particular, pulses of current of 1.0 to 0.01 ms are applied to the diodes, in order to obtain focussed images, in particular of the adhesive trail, while the sensor scans over the substrate.

[0027] Moreover, for a three-dimensional positional correction with regard to positional tolerances of the individual components and/or tolerances of joining seams, ills advantageous for the reference contour and/or a feature to be determined by at least two cameras, in order to carry out a three-dimensional positional correction for the application facility by means of the stereometry procedure.

[0028] It is also advantageous if the two cameras record the substrate, a section of the component or one or more components in the form of a full image or large image, whereby the full images or large images of the two cameras comprise an overlapping area in leading direction, and whereby the three-dimensional recognition of reference contour position resulting in the overlapping area is used for gross adjustment of the application facility prior to applying the structure. In this context, corresponding correction values are transmitted to the application facility and/or the robot in order to shift its coordinate system for the application of adhesive agent.

[0029] If a projection is made onto the area of the reference contour for three-dimensional analysis, in particular if one or more laser lines are applied to the substrate in the form of a projection, then a three-dimensional analysis of the profile with regard to the height and contour of arbitrary components can be facilitated even though this is not analyzable by common image processing without an additional projection.

[0030] Advantageously, the individual cameras are calibrated in order to assign

the angle assignment of the individual cameras according to the circular caliper, whereby in particular a circular arc of the calibrating device with marker points at 0°, 120°, and 240° for three cameras is used. This allows a global coordinate system to be used with regard to the angle assignment for the individual cameras on the circular caliper around the application facility to simplify the processing by the software.

[0031] Moreover, the distance of the application facility from a feature of the component, for example from edges of the component or holes and/or breakthroughs, can be measured in order to carry out a positional test of the applied structure. In this context, in particular, a line-shaped gray scale value scan and/or line-shaped calipers are used for distance measurement such that any number of reference markers can be placed, whereby the image processing is not exclusively limited to the camera image, in which the adhesive trail test is carried out. It is therefore not necessary for the adhesive trail and suitable reference features to be visualized in the same camera image, which is of advantage in particular with regard to the parallel processing of three camera images.

[0032] The present invention provides an apparatus for recognizing a structure to be applied onto a substrate, preferably an adhesive line or adhesive trail, for carrying out a method according to the invention according to claim 1 and/or 4, whereby at least one illumination module and one sensor unit are provided. The sensor unit is made up of at least one or more cameras that are provided and arranged around the facility for applying the structure, and each are directed at the facility for applying the structure. By this means it is feasible for the travel path of the facility over a substrate and/or a travel path of the substrate relative to the application facility to be monitored at all times in all directions by means of directing the cameras at the application facility.

[0033] If the axial longitudinal axis of the individual cameras essentially intersects, in the direction of view, the axial longitudinal axis of the application facility, it is advantageous according to a development of this type that a narrow area around the application facility can be monitored at suitable resolution and high image recording rate.

[0034] According to a preferred embodiment, individual cameras, in particular 3 cameras, are arranged at equal distances from each other in the direction of the circumference.

[0035] Advantageously, the individual cameras are circuited such that the images of the cameras are stored in a sequence of images such that these images can be recorded synchronously and in parallel as well as in an assigned fashion.

[0036] According to a development of an invention, one or more cameras form a circular caliper whose center is formed by the application facility of the structure. In this context, one or more circular calipers can be used that facilitate the determination of the edge of the adhesive trail on a circular line.

[0037] According to a preferred embodiment, the individual cameras comprise an overlapping area of at least 10° each relative to the next camera. This overlapping area facilitates fully automatic switching between neighboring cameras when the adhesive trail progresses from the monitoring area of one camera to the next, since the selection of the camera is not bound to the robot position or a time component, but rather always refers to the actual inspection results, i.e. is based on the arrangement on the orbit and/or circular line of the circular caliper and/or the global coordinate system formed thereby.

[0038] Moreover, it is advantageous for the illumination module to be made up of LEDs, in particular infrared LEDs, UV LEDs or RGB LEDs.

[0039] Moreover, it is of advantage to use a calibrating disc with individual form elements for calibrating the individual cameras for the assignment of the angle assignment, whereby said form elements comprise, in particular, an angle distance of essentially 10°. This allows for assignment of the scaling factor, angle assignment, and center as well as radius of the search circle for the individual cameras. According to the invention, the calibrating disc comprises at least three marker sites that are arranged in a circular arc of the calibrating disc of essentially 0°, 120 °, and 240 °, in order to calibrate three cameras.

[0040] If a projection facility projecting one or more features, in particular strips, onto the substrate for the three-dimensional analysis is provided on the application facility, arbitrary components can be used for correction and/or adjustment of the application facility prior to applying the structure.

[0041] According to a preferred embodiment, the projection facility emits one or more laser lines for three-dimensional profile analysis. Arranging at least two projection facilities around the application facility facilitates gap-free three-dimensional analysis around the application facility, whereby the analyses of sealing agent height and sealing agent contour as well as position and width can be carried out according to the principle of triangulation by means of image processing.

[0042] Further advantageous developments of the invention are the subject of the remaining subclaims.

[0043] Advantageous developments of the invention shall be illustrated in an exemplary fashion by means of the following drawings.

[0044] Figure 1 shows a schematic side view of an apparatus according to the invention for application and monitoring of an adhesive trail.

[0045] Figure 2 shows a perspective view of the apparatus according to the invention of Figure 1.

[0046] Figure 3 shows the travel path of the apparatus according to the invention for application and monitoring of an adhesive trail.

[0047] Figure 4 shows another travel path of the apparatus according to the invention with regard to the switching of the relevant camera.

[0048] Figure 5 is a view of a single image composed of three image strips from three cameras for online monitoring.

[0049] Figure 6 illustrates the principles of the design of the software.

[0050] Figure 7 shows a schematic view of a calibrating device according to the invention for calibrating the individual cameras of the apparatus according to the invention for recognizing a structure to be applied onto a substrate.

[0051] Figure 8 shows a top view onto the substrate with the adhesive trail applied with regard to monitoring the application.

[0052] Figure 9 shows a top view with regard to analysis of the profile.

[0053] In the following, the design of the apparatus according to the invention for recognizing a structure to be applied onto a substrate is illustrated according to Figures 1 and 2.

[0054] Reference number 10 indicates the schematically shown apparatus for application and recognition of an adhesive trail. In the center of the apparatus according to the invention is arranged an application facility 11 by means of which an adhesive trail 20 is applied onto a substrate and/or onto a sheet of metal 30 proceeding from right to left in Fig. 1. Three cameras 12, 13, 14 are arranged at equal distances from each other in a circle around the application facility ii, each of which is directed at the application facility 11. As is evident from Figure 1, the axial longitudinal axes of the three cameras 12, 13, 14 intersect the axial longitudinal axis of the application facility 11 just below the substrate 30 such that the focus of the individual cameras is arranged right around the area of the application facility 11, in particular, on a circular line.

[0055] In the inspection of the adhesive, either the application facility with the cameras or the substrate is moved, whereby the adhesive trail 20 is simultaneously applied to the substrate 30 by means of the application facility 11, and whereby the cameras 12, 13, 14 monitor the applied structure. For this purpose, it is feasible to move either the application facility with the cameras or the substrate In order to apply the adhesive trail onto the substrate 30 such as to follow a desired progression. By this means, the cameras being moved along can monitor, independent of the path of travel,

the adhesive frail at the time it is being applied. In Fig. 2, the adhesive trail 20 progresses from left to right and is indicated by a continuous line. The intended progression of the adhesive trail 20 is indicated by a dashed line to the right of the application facility 11.

[0056] Figure 3 then shows the progression of the adhesive trail 20 as indicated by arrows, whereby the direction and/or field of view of the three individual cameras is shown in three sites. The field of view of the three individual cameras each is indicated by a rectangle drawn with a continuous line, a rectangle drawn with widely dashed lines, and a rectangle drawn with narrow dashed lines. As is evident from Figure 3, the direction of the individual fields of view of the cameras remains constant at all times whereby only the whole apparatus is moved.

[0057] Figure 4 shows another progression of an adhesive trail 20, whereby it is indicated in each case, which held of view is active, i.e. which camera having the corresponding field of view shown as a rectangle is active while traveling along the adhesive trail.

[0058] Figure 5 then shows three image strips which each represent a relevant section and/or strip of image of the three individual cameras of Figure 1. According to the method of the invention, each camera records just a strip of the image in order to reduce the amount of data accordingly such that the recording rate can be increased. These individual image strips of the three cameras are then joined into an image, whereby the image recording occurs at defined fixed time intervals and independent of the robot control of the application facility. For example, the cameras only record a strip of the image, whereby instead of an image height of 450 pixels an image height of approx. 100 pixels (100 image lines) is used. By means of this partial scanning technique, i.e. partial reading-out of the image recording chip, only small data streams are generated such that the image recording rate can be increased several-fold accordingly. It is therefore feasible in the data analysis to capture the images of the individual cameras synchronously and in parallel and therefore simultaneously and then join them into a single image, whereby the three Image strips are arranged one below the other. As a result, the three images, i.e. the three image strips, are correctly arranged and assigned with regard to location and lime

relative to each other without further ado, and can be processed accordingly. This specific image recording technique therefore facilitates simultaneous and parallel recording of individual camera images, whereby it becomes feasible to scan this structure just once during the teach-in of a reference application structure, whereby the images of all cameras are stored in a sequence of images.

[0059] Once the images of the three cameras are stored in a sequence of images, a parameterization of this reference track is carried out as the subsequent step of teaching-in the reference adhesive trail. The robot travel path, robot travel time, direction, width, and quality of the adhesive trail are used in the parameterization. This results in a type of vector chain for the adhesive trail which allows to attain the high image recording rate and comparably short partial sections (between 1 and 3 mm). Vectorization has another advantage in that the adhesive trail, being in the form of a vector chain, can be stored in a camera-transcending global coordinate system.

[0060] As is evident from the bottom strip of Figure 5, a circular line is arranged around the center of the application facility 11 in the form of a circular line, whereby the two edge points 21 and 22 of the adhesive trail 20 are arranged on the circular line. This circular line is subdivided such that a range of angles from -10° to 130° is assigned to a first camera, a range of angles from 110° to 250° is assigned to a second camera, and a range of angles from 230° to -10° is assigned to a third camera such that gapless coverage around the application facility 11 by overlapping areas of the individual cameras is facilitated. From this results a global coordinate system for the three image strips that can be provided to be Cartesian or polar.

[0061] If the adhesive trail progresses out of the field of view of a camera, the adhesive frail is transiently in the overlapping area of the ranges of angles of the two cameras. If the adhesive trail then progresses from the segment of the circular line of the one camera via the overlapping area to the segment of the circular line of another camera, an automatic switch is made from the one to the other camera. This is shown, in particular, in Figure 4 by means of the active fields of view of the individual cameras.

[0062] The advantages mentioned above are attained by the individual cameras forming a circular caliper whose center is formed by the application facility 11, whereby the search for the edges 21, 22 of the adhesive trail proceeds on a circular line directly around the application facility. For this purpose, it is essential that the individual cameras are directed at the application facility, whereby the axial longitudinal axes of the individual cameras intersect the longitudinal axis of the application facility.

[0063] A teach-in run and/or a teach-in of a reference adhesive trail is illustrated in the following.

[0064] The teach-in process of the reference adhesive trail can be started by the user by means of a mouse click on the track which indicates the position of the adhesive trail. This is sufficient for fully automatic recognition of position and direction of the adhesive trail in the subsequent camera images, since the image recording rate is sufficiently high and the individual images are recorded very shortly after one another, for example every 1 mm to 3 mm. From the starting point, the adhesive is scanned image by image, whereby the adhesive trail position and the adhesive trail angle detected in the current image are used for the upcoming image as a priori knowledge. The fact that the track radii usually exceed 20mm facilitates fully automatic capture of the adhesive trail without a human being having to determine and/or assess the image and/or the position of the adhesive trail. As a result, the search area can be limited which allows, by means of the high image recording rate, to calculate where the adhesive frail will essentially progress in the following image.

[0065] Figure 6 shows the principles of the design of the software, whereby the teach-in run and/or teach-in run generates the image sequence, which in turn facilitates the automatic parameterization. This parameterization can be pro-set by the user, if applicable, and is used jointly with a progression file for inspection of an applied adhesive trail during the inspection run.

[0066] The online monitoring of an applied adhesive trail shall be illustrated briefly in the following. The application facility 11 shown in Figure 1 applies the

adhesive trail onto the metal sheet 30, whereby the application facility ii is moved jointly with the cameras over the metal sheet 30. However, a kinematic Inversion is also feasible, i.e. the metal sheet 30 being moved and the application facility with the cameras being arranged to be fixed in position. The applied adhesive trail 20 is determined and analyzed synchronously and in parallel by the cameras 12, 13, 14 on the circular line of the circular caliper illustrated according to Figure 5, whereby each camera records only a strip of the image and joins these into a single image to form a sequence of images. The image recording rate is increased in accordance with the data reduction attained by each camera recording only a strip of the image, whereby the individual image strips in the joint image facilitate the synchronous and parallel as well as simultaneous capture of the three camera images, and whereby the individual images of the three cameras can be assigned directly as a function of location. As a result, online monitoring of the adhesive trail in real-time is feasible that achieves high accuracy at high travel speeds due to the high image recording rate both in teaching-in a reference adhesive trail and in the inspection of the applied adhesive trail. In this context, the information concerning the adhesive trail in the adhesive search area, the angle assignment of the sensor, the adhesive assessment, the robot travel path, and the robot travel time are summarized in a progression list.

[0067] According to an embodiment of the present invention, an assessment function, in particular a fuzzy assessment, can be used to find the edges of the adhesive trail in order to determine and assess the adhesive trail, the following parameters are included in the calculation of a fuzzy assessment.

[0068] Width of the pair of edges (edge 1: left edge of the adhesive trail, edge 2: right edge of the adhesive trail), mean gray scale value of the projected gray scale value profile between the pair of edges, edge contrast (geometric mean of the amplitudes of the two edges), and progression of position (directed deviation of the center between tie two adhesive edges from the center of the search area, in pixels). By means of this plurality of parameters, and the use of the fuzzy assessment function, the adhesive trail can be described very accurately such that the adhesive frail can be recognized automatically in a reliable fashion.

[0069] The illumination module (not shown here) far the apparatus according to the invention is made up of LEDs, in particular infrared LEDs, UV LEDs or RGB LEDs. In order to attain high contrast in image recording, the LEDs can be flashed, i.e. short, strong pulses of current on the order of 1.0 to 0.01 ms can be applied to the diodes. In this context, light-emitting diodes capable of emitting light of various colors are particularly advantageous such that the sensor design can be switched to other types of adhesive and/or colors of adhesives without reconfiguration.

[0070] Figure 7 shows a calibration facility 40 in the form of a circular calibrating disc in order to assign to the individual cameras their scaling factor, their angle assignment, and the center as well as the radius of the search circle. The calibrating disc consists of individual form elements and/or dots 41 that are arranged on a circular line and at an angle distance of essentially 100. Moreover, marker sites 42 are arranged at equal distance from each other in order to calibrate three cameras. A compensation calculation is used to calculate from the coordinates of the centers of the individual dots, on the one hand, the scaling factors of the individual cameras and, on the other hand, the center as well as radius of the search area. The marker sites at angles of 0°, 120°, and 240° in the global coordinate system allow the angle assignment and the corresponding fields of view of the individual cameras to be determined. The field of view of the individual cameras is indicated, in particular, by the three rectangles in Figure 7, whereby the form elements 41 can correspond to the circular line of the circular caliper for detection of the adhesive trail.

[0071] Figure 8 shows the application facility 11, whereby the strips 31, 32, and 33 around the application facility 11 each are shown by dashed lines and represent the read-out area of the individual cameras. The adhesive trail 20 is monitored in the overlapping area of the strips 32 and 33 such that these two cameras are active. If the progression of the adhesive trail relative to the application facility 11 changes, only one, if applicable, of the cameras becomes active, whereby an essentially circular caliper (not shown) that is arranged to be concentric around the application facility 11 is used for this purpose.

[0072] According to this embodiment, the circular caliper is formed by multiple cameras that are arranged around the application facility, but, in particular, can be attached at a different radius from the center of the application facility. For inspection of an application structure and/or adhesive trail, the cameras are directed at a circle and/or circular line whose center coincides with the center of the application facility. The optical detection of the adhesive trail as illustrated above then proceeds on this circular line.

[0073] The three-dimensional profile analysis by means of a projection is described according to Figure 9, in order to provide for a positional correction of the application facility. For reasons of clarity of presentation, fig. 9 again shows only two camera fields of view 51, 52 indicated by dashed lines. In the overlapping area of the two camera holds of view 51, 52 are shown a plurality of laser lines 60 that are used for profile analysis with regard to the width and contour of structure lines and for generation of so-called soft contours. The laser lines 60 are generated by a projection facility that can, for example, be arranged on the optical sensor with three cameras. Moreover, the projection facility can just as well be arranged directly on the application facility 11. The sensor with the three cameras is shown schematically by the circle 70. The laser lines and/or laser strips projected onto the component 30 and/or metal sheet 30 highlight contours on the component that cannot be used for three-dimensional analysis by conventional image processing. Artificial features are generated by means of the laser tines on the component and can subsequently be analyzed by means of image processing according to stereometry. Thus, Figure 9 shows the principle of three-dimensional positional recognition prior to the application of sealing agent in case no hard, analyzable features are present.

[0074] Therefore, a method and/or an apparatus for recognizing a structure to be applied onto a substrate, preferably an adhesive line or adhesive trail, with at least one camera, in particular multiple cameras, is described. In this context, the teach-in of a reference application structure is carried out by means of just a single scan of said reference application structure such that the images of all cameras are stored in a sequence of images.

[0075] Moreover, a method for recognizing a structure to be applied onto a substrate is described, whereby the applied structure is processed as an optical representation during the scan for assessment of the structure such that each camera records just a strip of the image to form a sequence of images and the image recording rate is increased in line with the data reduction achieved by recording only a strip of the image.